

The University of Chicago

FAUNA OF THE NIAGARAN
NODULES OF THE CHICAGO AREA

A PART OF A DISSERTATION SUBMITTED TO
THE FACULTY OF THE DIVISION OF THE
PHYSICAL SCIENCES IN CANDIDACY FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF GEOLOGY AND PALEONTOLOGY

1939

By
DAVID MARION GRUBBS

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FAUNA OF THE NIAGARAN NODULES OF THE CHICAGO AREA

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ABSTRACT—Nodules consisting of nuclei of siliceous fossils in a matrix of calcium carbonate occur in the Niagaran dolomite near Chicago. The nodules contain an invertebrate fauna of small individuals comprising 52 genera and 66 species of which 9 genera and 34 species are herein described as new.

SILICEOUS NODULES are common in exposures of the Niagaran dolomite in the many quarries in and adjacent to Chicago. Another type of nodule, which was discovered in 1930, consists of numerous silicified fossils, intermeshed and embedded in a matrix dominantly of calcium carbonate. These structures are spheroidal in character, commonly depressed-elliptical in section, and range in maximum dimensions from about 5 to 20 centimeters. The mode of their origin has been postulated in a previous paper.¹

Investigation of the available outcrops has yielded a single occurrence of the nodules. This is in a restricted zone, 52 feet below the top of the dolomite as exposed in the Federal Stone Company quarry at the western limits of Chicago. The nodules have a vertical extent of about 3 feet and a sporadic lateral occurrence of about 400 feet.

For this study the siliceous fossils were removed from the nodule matrix by digestion with dilute acid. Most of the forms have been replaced by silica in such manner that the details of their structure are well preserved, but in some groups, notably the bryozoans, the microscopic wall structure has been obliterated and specific determina-

tions are impossible. Altogether, the fauna comprises 52 recognized genera and 66 species of which 9 genera and 34 species are herein described as new. In addition there is much fragmental material, dominantly echinodermal, which has not been included in the above recapitulation. For the sake of brevity, only new species are included in the descriptive portion of the paper, but in addition the following Silurian forms have been recognized in the fauna:

Thurammina irregularis Moreman
Thurammina arcuata Moreman
Pycnostylus? sp.
Spirorbis inornatus Hall
Troostocrinus reinwardti (Troost)
Parmorthis waldronensis (Foerste)
Rhipidomella hybrida (Sowerby)
Anastrophia internascens Hall
Pentamerus oblongus Sowerby
Conchidium laqueatum (Conrad)
Rhynchotreta cuneata americana (Hall)
Camarotoechia indianensis (Hall)
Atrypa nodostriata Hall
Delthyris crispus (Hisinger)
Spirifer radiatus (Sowerby)
Meristina cf. *maria* (Hall)
Whitfieldella cf. *nitida* (Hall)
Whitfieldella cylindrica (Hall)
Conocardium niagarense Winchell & Marcy
Strophostylus cyclostomus Hall
Diaphorostoma niagarense (Hall)
Actinoceras? sp.

Since the fauna includes a relatively great number of new species and few diag-

¹ Croneis, Carey, and Grubbs, D. M., 1939, Silurian Sea Balls: *Jour. Geology*, vol. 47

nostic previously described forms, it is difficult to arrive at any definite conclusions as to the correlative position of the nodules. There is, however, a resemblance between the assemblage of the nodules and that of the Racine dolomite in the adjacent areas. Several of the species common to the two faunas are identical in all respects except in size, and with few exceptions the forms in the nodules are from one-third to one-half the size of the Racine species. Otherwise the individuals have all of the characteristics of mature species.

All of the material herein described comes from a nodular zone in the Federal Stone Company quarry near Chicago.

Holotypes and paratypes are deposited in the Walker Museum of Paleontology, University of Chicago.

The writer is indebted to Dr. Carey Croneis, Walker Museum, University of Chicago, for his direction and assistance in preparation of this manuscript.

SYSTEMATIC DESCRIPTIONS

Phylum PROTOZOA

Order FORAMINIFERA

Family RHIZAMMINIDAE

Genus *ARENOSIPHON* Grubbs, n. gen.

Test free, cylindrical, rarely branching, commonly tapering slightly, straight or slightly curved, occasionally constricted at intervals; wall of medium to fine sand grains, firmly cemented; surface rough; apertures at ends of tube.

Genotype, *Arenosiphon gigantea* Grubbs, n. sp.

Remarks.—This genus has been erected to include a large foraminifer which occurs abundantly in the nodules. It differs from other genera of the family in its generally large size and in that the test was formed by selection of apparently only quartz grains of nearly uniform size, a rough surface resulting. Several small Silurian forms, which have been referred to the genus *Bathysiphon* by some workers, possibly belong here.

ARENOSIPHON GIGANTEA Grubbs, n. sp.

Plate 61, figures 1–3

Test free, generally large, cylindrical, rarely branching, commonly tapering uniformly or irregularly, straight or in most cases somewhat curved, in some cases con-

stricted externally; wall of medium to fine quartz grains, firmly cemented; surface rough; apertures circular, at one or both ends of the tubes, occasionally of smaller diameter than maximum of tube.

Dimensions of holotype: length, 12.0 mm; greatest diameter, 0.9 mm; average of several specimens: length, 14.0 mm; diameter, 1.0 mm.

Holotype, no. 46000; paratypes, no. 46001.

Remarks.—This species is characterized by its relatively large size, by the type of material of the test, and by the surface texture.

Family STEGNAMMINIDAE

Genus *SOROSPHAERA* H. B. Brady, 1897

SOROSPHAERA IRREGULARIS Grubbs, n. sp.

Plate 61, figure 4

Test free, composed of two or more subspherical chambers in a single plane, chambers attached but not communicating with each other, flattened at the junctions and in some cases slightly flattened on one or more sides; wall thin, composed of fine sand with much cement; surface smooth except for a few short spines; apertures not apparent.

Dimensions of holotype: length of test, 1.1 mm; diameter of individual cell, 0.25 mm.

Holotype, no. 46002; paratypes, no. 46003.

Remarks.—This form is related to *S. tricella* Moreman and other Silurian species. Several species have been erected in which the determination apparently was based on the number of cells, but from the material at hand it is evident that a rupture of some of the composite individuals would obviously produce several new ones having variable numbers of chambers. Thus, a specific description would possibly apply to only a single individual. Forms of such variable attributes are here grouped into one species.

Family SACCAMMINIDAE

Genus *LAGENAMMINA* Rhumbler, 1911

LAGENAMMINA CORNUTA Grubbs, n. sp.

Plate 61, figures 5, 6

Test free, subspherical; neck short, horn-like, tapering, producing asymmetry by an

undulation in the test on the concave side of the neck; wall thick, composed of fine sand grains, well cemented; surface rough; aperture circular, located at the end of the short neck.

Dimensions of holotype: length, including neck, 0.55 mm; maximum diameter, 0.49 mm.

Holotype, no. 46004; paratypes, no. 46005.

Remarks.—This species resembles *L. sphaerica* Moreman in shape and surface texture, but differs in regard to its much shorter, tapering neck. Uncommon in the samples.

Genus THURAMMINA H. B. Brady, 1879

THURAMMINA UNITUBULA Grubbs, n. sp.

Plate 61, figure 7

Test free, flask-shaped, slightly compressed; wall thin, composed of medium sand grains, well cemented; surface rough; aperture circular, located at the end of a single prominent tube.

Dimensions of holotype (no. 46006): length, including tube, 0.43 mm, maximum diameter of body chamber, 0.37 mm.

Remarks.—This species is represented by a single individual. It differs from others in that it has a single apertural tube.

THURAMMINA CYLINDRICA Grubbs, n. sp.

Plate 61, figure 13

Test free, cylindrical; wall thin, composed of fine sand grains, well cemented; surface smooth; apertures at the end of small nipplelike projections, irregularly spaced, more numerous near the margins.

Dimensions of holotype: length, 0.39 mm; diameter, 0.31 mm.

Holotype, no. 46007; paratypes, no. 46008.

Remarks.—This species is distinguished by its cylindrical shape and the concentration of the apertures near the ends of the cylinder. Rare in all samples.

THURAMMINA GLOBULA Grubbs, n. sp.

Plate 61, figures 9, 10

Test free, biscuit-shaped, subcircular in outline, flattened below; wall thin, composed of fine sand grains, well cemented; surface smooth; apertures at the end of short nipplelike projections, seven or eight

in number, subsymmetrically arranged around the periphery of the test.

Dimensions of holotype (no. 46009): greatest diameter, 0.68 mm; short diameter, 0.5 mm.

Remarks.—This species resembles *T. sub-sphaerica* Moreman in outline but differs in its much shorter apertural tubes. Rare.

Family PLACOPSILINIDAE

Genus PLACOPSILINA d'Orbigny, 1850

PLACOPSILINA? LINEATA Grubbs, n. sp.

Plate 61, figures 11, 12

Test attached, of several chambers connected in a linear series; chambers pyriform in outline, attached by flattened lower surface, sharply convex above; wall thin, hyaline; surface smooth; one aperture at the broader end of each chamber, circular, near the center of a subtriangular face which is perpendicular to the plane of attachment; connections between chambers constricted, originating near the base of chamber, below the aperture.

Dimensions of holotype: length of individual chamber, 0.55 mm; greatest width, 0.37 mm; height, 0.18 mm.

Holotype, no. 46010; paratypes, no. 46011.

Remarks.—This rather common form is questionably placed in this genus since sufficient diagnostic material was not available to establish its true relationships. It differs from described species in that apertures are present on each chamber; the outline is similar to *P. rostrata* Quenstedt. The species probably belongs to a new genus.

Phylum COELENTERATA

Class HYDROZOA

Family MONOGRAPTIDAE

Genus MONOGRAPTUS Geinitz, 1852

MONOGRAPTUS? CHICAGOENSIS Grubbs, n. sp.

Plate 61, figure 20

Stipe slender, simple, linear, generally slightly curved; dorsal margin undulating, without a rigid virgula. Polyps subpyriform, slightly truncated distally, nearly paralleling the axis of growth, the ventral margin forming an angle of about 10 degrees with the axis. The polyps originate from one side of a common subcylindrical, coe-

nosarcal canal which is constricted at the points of addition of the new individuals; polyps added uniformly, with no overlap, a new one arising at the point where the plane of the aperture of the preceding polyp intersects the common canal. Apertures slightly elliptical, occupying most of the somewhat flattened face of the anterior margin, direction of aperture elongation at a right angle to the axis of growth, the plane containing the aperture nearly perpendicular to the axis. Surface apparently smooth.

Dimensions of holotype: length of stipe, 1.7 mm; length of individual polyp, 0.49 mm; diameter at aperture, 0.12 mm.

Holotype, no. 46012; paratypes, no. 46013.

Remarks.—This species is represented by a few individual stipes and a number of fragments. All have been referred doubtfully to this genus because the material is not sufficient to determine positively its true generic relationships. The lack of a rigid virgula is a discordant character in these

forms, which otherwise seem to show strong graptolite affinities.

Class ANTHOZOA

Family CYATHAXONIDAE

Genus ASTHENOPHYLLUM Grubbs, n. gen.

Simple turbinate or trochoid coralla of which the calyces occupy about two-thirds the height of the individuals; septa moderately strong, radially disposed, extending uninterrupted to the bottom of the calyces where they reach the center and twist slightly into a pseudocolumella. Septal insertion according to the *Zaphrentis* plan—six protosepta, usually 16 metasepta, finally a minor series inserted in the intervening spaces and remaining rudimentary. Tabulae and dissepiments are lacking in the mature forms; cardinal septum neither in a fossula nor aborted; epitheca marked with rather strong rugae.

Genotype, *Asthenophyllum orthoseptatum* Grubbs, n. sp.

EXPLANATION OF PLATE 61

- FIGS. 1–3—*Arenosiphon gigantea* Grubbs, n. gen. and sp., $\times 3$. 1, 3, Paratypes; 2, holotype (p. 544)
 4—*Sorosphaera irregularis* Grubbs, n. sp. Holotype, $\times 18$. (p. 544)
 5, 6—*Lagenammina cornuta* Grubbs, n. sp., $\times 20$. 5, Paratype; 6, holotype. (p. 544)
 7—*Thurammina unitubula* Grubbs, n. sp. Holotype, $\times 20$. (p. 545)
 9, 10—*Thurammina globula* Grubbs, n. sp. 9, Upper surface of holotype, $\times 18$; 10, lateral view of holotype, $\times 20$. (p. 545)
 11, 12—*Placopsilina? lineata* Grubbs, n. sp., $\times 20$. 11, Dorsal view of holotype; 12, lateral view of paratype. (p. 545)
 13—*Thurammina cylindrica* Grubbs, n. sp. Holotype, $\times 20$. (p. 545)
 14–18—*Asthenophyllum orthoseptatum* Grubbs, n. gen. and sp. 14–16, Lateral view of paratypes, $\times 2\frac{1}{2}$; 17, calicular view of holotype, $\times 2$; 18, lateral view of holotype, $\times 1\frac{1}{2}$. (p. 547)
 8, 19—*Favosites radiculatus* Grubbs, n. sp., $\times 8$. 8, upper surface of paratype; 19, basal view of holotype. (p. 548)
 20—*Monograptus? chicagoensis* Grubbs, n. sp., $\times 15$. Lateral view of holotype. (p. 545)
 21, 22—*Favosites michelinoides* Grubbs, n. sp., $\times 3$. 21, Lateral view of holotype; 22, upper surface of holotype. (p. 548)
 23—*Favosites variporous* Grubbs, n. sp., $\times 2\frac{1}{2}$. Upper surface of holotype. (p. 548)
 24–26—*Auloporella typa* Grubbs, n. gen. and sp., $\times 2\frac{1}{2}$. 24, Sectional view of paratype; 25, holotype; 26, paratype. (p. 549)
 27–29—*Aulooza constricta* Grubbs, n. gen. and sp. 27, Paratype, $\times 3\frac{1}{2}$; 28, holotype, $\times 3$; 29, paratype, $\times 6$. (p. 549)
 30—*Spirorbis carinacinctus* Grubbs, n. sp., $\times 12$. Dorsal view of holotype. (p. 550)
 31, 32, 35—*Cyathocrinus? nanus* Grubbs, n. sp., $\times 18$. 31, Lateral view of holotype; 32, oral view of paratype; 35, lateral view of paratype. (p. 550)
 33, 34—*Cornulites perspinosus* Grubbs, n. sp., $\times 8$. 33, Dorsal view of holotype; 34, dorsal view of paratype. (p. 550)
 36, 38—*Proastrum rectibrachium* Grubbs, n. gen. and sp. 36, Dorsal view of holotype, $\times 10$; 38, ventral view of holotype, $\times 11$. (p. 551)
 37—*Ceramoporella racinensis* Grubbs, n. sp., $\times 3$. Upper surface of holotype. (p. 551)
 39, 40, 47—*Pholidopora concentrica* Grubbs, n. gen. and sp., $\times 4$. 39, Basal view of paratype; 40, upper surface of paratype; 47, upper surface of holotype. (p. 552)
 41–43—*Liodemella clava* Grubbs, n. sp., $\times 1\frac{1}{2}$. 41, Lateral view of holotype; 42, 43, lateral view of paratypes. (p. 552)
 44–46—*Pseudohornera? varipora* Grubbs, n. sp., $\times 7$. 44, Obverse surface of holotype; 45, reverse surface of holotype; 46, obverse surface of paratype. (p. 553)



Grubbs, Niagaran fauna

Remarks.—This genus is based on numerous individuals of variable shapes, which have identical septal characteristics and lack tabulae, dissepiments, and fossulae. The deep calyces and the absence of cardinal fossulae, together with the attributes mentioned, separate this genus from previously described forms. The genus is placed with some question in the family *Cyathaxonidae* because the classification of the rugose corals has not yet been satisfactorily developed.

ASTHENOPHYLLUM ORTHOSEPTATUM

Grubbs, n. sp.

Plate 61, figures 14–18

Coralla simple, varying in outward form, generally slightly curved-trochoid at maturity; in the neanic stages increasing the diameter slowly, then flaring rapidly in an erectly turbinate fashion, the apex commonly truncated, otherwise remaining sharply acuminate. Calyx deep, constituting as much as two-thirds of the lumen; calicular opening subcircular to ovoid in outline. Septa unornamented, moderately strong, blade-like, radially disposed, slightly expanded at the peripheral edge but otherwise nearly plane; distally the septa are more or less confined to the calicular walls or extend axially for only a slight distance; vertically they extend uninterrupted to the bottom of the calyx, where they reach the center and twist slightly to form a pseudocolumella, which structure generally confines a vertical axial opening or fenestrula formed by the septa twisting around the axis.

The septal insertion follows the *Zaphrentis* plan, i.e., after the protosepta, metasepta are inserted at four points simultaneously, immediately on each side of the cardinal septum and on the counter side of each alar septum. In the primary stage the cardinal and counter septa are conjoined to form an axial septum and with the alar and counter-lateral septa produce six protosepta (figure 1a). The addition of the first four metasepta in their proper positions forms 10 major septa (figure 1b). Additional metasepta are inserted in groups of four to produce neanic stages of 14 (figure 1c), 18 (figure 1d), and finally 22 (figure 1e) major septa.² When the

number of major septa reaches 22 (occasionally 20), minor septa are added simultaneously in a cycle, in the intervening loculi, to make a total of 44, the maximum septal number observed. The minor septa remain as rudiments, usually as vertical rows of spines.

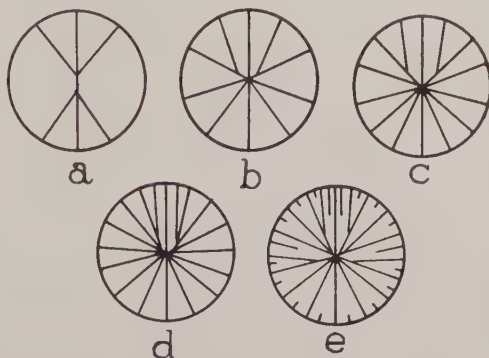


FIG. 1.—Septal development (diagrammatic) in *Asthenophyllum orthoseptatum*.

Tabulae and dissepiments lacking in mature forms, but horizontal, complete tabulae occur sporadically in the proximal portion of the lumen in some neanic coralla. Fossulae altogether lacking; cardinal septum never aborted nor reduced. Epitheca characterized by strong rugae, which do not affect the endodermal wall, and occasional marks of rejuvenescence; longitudinal striae or grooves not observed.

Dimensions of holotype: length of corallum, 7.5 mm; diameter at distal end, 7.0 mm.

Holotype, Walker Museum, no. 46014, paratypes, no. 46015.

Remarks.—The size and septal characters, together with the lack of fossulae, make this species distinctly different from other rugose corals.

² It has been noted that although the septa are essentially inserted in groups of four, there is a tendency for one pair to slightly precede the other. The pair on the counter side of the alar septa seem to develop momentarily before the contemporaries adjacent to the cardinal septum. This, in the neanic stages, produces individuals which show 12, 16, and 20 septa that extend entirely to the bottom of the calyx and reach the center.

Family FAVOSITIDAE

Genus FAVOSITES Lamarck, 1812

FAVOSITES RADICULATUS Grubbs, n. sp.

Plate 61, figures 8, 19

Corallum small, composite, hemispherical, attached by a short, subcentral peduncle; lower surface convex, covered with a concentrically striated epitheca; upper surface flat or gently convex; corallites prismatic, pentagonal or hexagonal, confined to the upper face. The young corallites are added around the periphery to produce an area with individuals of smaller diameter than the more mature central ones, those near the margins radiating at a considerable angle from the principal axis of growth. Walls in contact throughout, of medium thickness, expanded slightly at the junctions with those adjacent, often with a slight surficial node rising from the common points of junction. Septa rudimentary, about 12 in number, represented by short sporadic spines in vertical rows; mural pores large, apparently in a single irregular row on each prism face; tabulae obsolete, or consisting of a few horizontal striae on wall surfaces.

Dimensions of holotype: greatest diameter of corallum, 2.4 mm, height including peduncle, 1.5 mm; diameter of average corallite, 0.3 mm.

Holotype, no. 46016; paratypes, no. 46017.

Remarks.—This coral may possibly represent an ontogenic stage of some other form; nevertheless, it is distinctive in its pedunculate attachment and the character of the tabulae. The large number of recognizable young corallites and the relatively larger number of mature ones further suggest that the species is valid.

FAVOSITES MICHELINOIDES Grubbs, n. sp.

Plate 61, figures 21, 22

Corallum small, composite, originating as a single tube, multiplying to form several tubes, and finally expanding rapidly into a globular cluster of corallites. Corallites commonly added as small clusters before the expansion of the main body of the corallum. The original tubular character is retained in part by many mature corallites, but

others assume a prismatic section due to crowding. Walls thin, in contact throughout, very slightly thickened at junctions with those adjacent; septa rudimentary, usually 12 or less in number, consisting of vertical rows of short spines; mural pores large, restricted to a single one to two adjacent corallites, a prominent raised margin encircling the pores; tabulae common but not abundant, usually with the upper surface convex but occasionally flat.

Dimensions of holotype: height of corallum, 7.0 mm; greatest diameter, 5.0 mm; diameter of average corallite, 0.7 mm; average of several specimens: height, 8.0 mm; diameter, 5.0 mm.

Holotype, no. 46018; paratypes, no. 46019.

Remarks.—As suggested by the trivial name this form has the outward appearance of several species of *Michelinia*; however, the porous nature of the walls places it in the genus *Favosites*. The tubular character of the corallites, the convex tabulae, and the single communicating pore for each of the contacting corallites are distinctive features of the species.

FAVOSITES VARIPOROUS Grubbs, n. sp.

Plate 61, figure 23

Corallum composite, bushy, attached; corallites prismatic, usually pentagonal or hexagonal, but varying from three to eight sides, increasing in diameter with growth. Walls moderately thick, in contact throughout, more massive at junctions with those adjacent; septa common, represented by from 12 to 16 vertical rows of rather strong, short spines; mural pores large, arranged in usually a single irregular row on each prism face but exceptionally occurring in two alternate rows, pores with a slightly expanded border. Tabulae horizontal, irregularly spaced, not numerous.

Dimensions of holotype: height of corallum, 3.5 mm; diameter, 9.0 mm; diameter of average corallite, 1.0 mm.

Holotype, no. 46020; paratypes, no. 46021.

Remarks.—This species differs from the common forms of *Favosites* in the arrangement of the mural pores and in the paucity of tabulae.

Family AULOPORIDAE

Genus AULOPORELLA Grubbs, n. gen.

Aulopora-like coralla with secondary inner chambers which produce a double wall; young corallites retaining communication with parent chambers; tabulae and septa apparently lacking.

Genotype, *Auloporella typa* Grubbs, n. sp.

Remarks.—The forms of this genus resemble *Aulopora* Goldfuss, emend. Fenton and Fenton, 1937, in outward appearance. A secondary inner chamber has been developed in the anterior portion of the individual corallites and forms a double-wall effect which extends into the young tubes as they are added.

AULOPORELLA TYPA Grubbs, n. sp.

Plate 61, figures 24–26

Corallites trumpet-shaped, attached by most of the lower surface, expanding toward the anterior; anterior directed vertically, the vertical portion often comprising as much as one-half the length of the individual; apertures circular, sometimes slightly constricted; walls thick; surface smooth or faintly wrinkled. New tubes are added near the base of the parent cup, often two or three to an individual, directed forward or at various angles, retaining communication with the parent. A secondary saclike chamber is produced in the anterior portion of the corallites and forms an inner wall, which is not in contact throughout with the outer, but with an intermediate open space; walls coalescing near the aperture. The double-wall character passes from the parent cup into the young as they are added. Septa rarely present; tabulae or diaphragms apparently lacking.

Dimensions of holotype: length of individual corallite, 6.0 mm, length of upturned portion, 2.0 mm; greatest diameter, 1.5 mm.

Holotype, no. 46022; paratypes, no. 46023.

Remarks.—Many species of *Auloporidae* have been inadequately described, especially in relation to the internal features, hence there is question as to the affinities of this species. Its external features are similar to several Silurian forms that have been assigned to the genus *Aulopora*, but

the distinctive internal character seems to warrant a new generic designation. It is likely that some previously described species belong to this genus. The forms are common in the nodules.

Genus AULOZOA Grubbs, n. gen.

Corallum attached, consisting of tortuous constricted tubes that maintain about the same diameter throughout; from one to five or six new tubes may be added within a short space by gemmation at any position around the parent, all of the tubes having the same general direction of growth, with a tendency to be directed slightly upward near the apertural end. Young tubes in communication with the parent by means of a small subcircular opening at the point of origin. Apertures circular; tabulae apparently lacking; septa rudimentary.

Genotype, *Aulozoa constricta* Grubbs, n. sp.

Remarks.—This genus differs from other aulopoid types in that it is attached by a limited portion of the lower surface and the tubes are constricted at numerous places and do not increase their diameter toward the aperture. The young tubes retain communication in an extraordinary manner.

AULOZOA CONSTRICTA Grubbs, n. sp.

Plate 61, figures 27–29

Corallum attached by a limited portion of the lower surface, consisting of small subcylindrical, tortuous, scoleoid tubes, constricted in many places, the tubes retaining nearly the same diameter throughout their length. The parent tube produces new individuals irregularly, adding from one to five or six new individuals in a short space, the tubes arising from any or several positions on the parent and forming in some cases a somewhat crowded cluster of individuals. The tubes diverge at different angles, but all have a general anterior direction of growth, and tend to be directed slightly upward near the apertural ends. Young tubes retain communication with the parent by means of a small subcircular wall opening at the point of origin; where crowded the tubes may be polygonal for a short distance but always retain their individuality. Apertures circular; tabulae ap-

parently lacking; septa consisting of a few rows of short spines.

Dimensions of holotype: length over all, 9.6 mm; diameter of average tube, 0.85 mm.

Holotype, no. 46024; paratypes, no. 46025.

Remarks.—This species is represented abundantly in the material. The differences between the genus and similar forms of the same family have been pointed out under the generic description; the same criteria apply to the species. It resembles in outward appearance the fresh water bryozoan genus *Plumatella*, and since the status of the auloporida corals is not clearly defined, this species may possibly belong to some other group.

Phylum ANNELIDA

Genus SPIRORBIS Lamarck, 1801

SPIRORBIS CARINACINCTUS Grubbs, n. sp.

Plate 61, figure 30

Shell a small spiraled tube of about two and one-half volutions, attached by one volution then ascending toward the apertural end. Aperture circular, with a slightly flared lip; surface ornamented with strong, sharp annulations that rise above the surface a distance equal to about one-half the diameter of the tube proper, eight or nine annulations to one volution. Longitudinal striae occupy the spaces between the annulations.

Dimensions of holotype (no. 46026): diameter of shell, 0.87 mm, diameter of aperture, 0.36 mm.

Remarks.—This species resembles *S. annulatus* Hall from the Salem limestone in general shape and appearance. It differs in that it is smaller, and the annular carinae are stronger, sharper, and more widely spaced.

Genus CORNULITES Schlotheim, 1820

CORNULITES PERSPINOSUS

Grubbs, n. sp.

Plate 61, figures 33, 34

Shell a small tubular cone, straight or slightly curved, flattened on lower surface for attachment. The shell in cross-section is subcircular, diameter increasing somewhat toward aperture; aperture circular, in some cases with a slightly flared lip. Surface with numerous rather strong spines,

irregularly spaced, directed anteriorly; annulations especially prominent on the interior of the shell.

Dimensions of holotype: length, 2.0 mm, diameter, 0.63 mm.

Holotype, no. 46027; paratypes, no. 46028.

Remarks.—The species has been placed in this genus with a degree of uncertainty. The attached mode of growth and the general shell shape are suggestive of *Cor-nulites*. The unusual spinosity is a distinctive feature.

Phylum ECHINODERMA

Class CRINOIDEA

Genus CYATHOCRINUS Miller, 1821

CYATHOCRINUS? NANUS Grubbs, n. sp.

Plate 61, figures 31, 32, 35

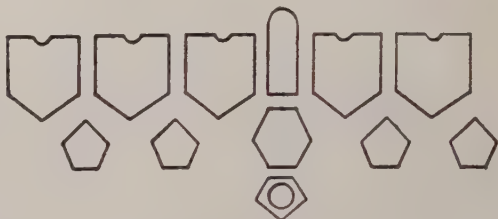


FIG. 2.—Plate arrangement (diagrammatic) of *Cyathocrinus? nanus*.

Calyx minute, cup-shaped, bilaterally symmetrical, arms free above the radials; plate arrangement dicyclic, three cycles of plates united by close suture. Proximal cycle, which apparently represents small infrabasals, fused into a single dorsally convex, pentagonal plate. Basals five, four of them equal, pentagonal, slightly convex below, the fifth, or posterior basal, hexagonal, extended slightly above the other basals. Radials five, larger than the basals, pentagonal, subequal, the two posterior plates slightly narrower; radial plates in contact except posteriorly where the anal plate is inserted in the cycle. The radials are evenly truncated above, semicircular arm facets occupying probably one-half of the upper margins, the facets directed outward. Anal plate in the radial cycle, resting on the truncated upper margin of the posterior basal plate, extending ventrally above the radials. Column circular; oral plates and arms not observed. Surface smooth.

Dimensions of holotype: height of dorsal cup, 0.62 mm; diameter at upper margin, 0.7 mm.

Holotype, no. 46029; paratypes, no. 46030.

Remarks.—The generic designation of this species is questionable since the tegmen and arms are not preserved. The arm facets are larger than is typical of the genus; the anal plate is somewhat more extended than in other species.

INCERTAE SEDIS

Genus PROASTRUM Grubbs, n. gen.

Shell pentagonally symmetrical, composed of a central body and five rigid arms in a plane, arms not an integral part of body cavity. Ventrally the arms are fitted with an alternating series of tuberculate plates. The body cavity bears an elevated centrodorsal plate with a median perforation.

Genotype, *Proastrum rectibrachium* Grubbs, n. sp.

Remarks.—This genus is erected to accommodate a single peculiar specimen whose symmetry indicates a relationship to the echinoderm group. As the plate arrangement is obscure it is impossible to classify the form properly; some features suggest relation to the asteroid group.

PROASTRUM RECTIBRACHIUM

Grubbs, n. sp.

Plate 61, figures 36, 38

Shell small, pentagonally symmetrical, consisting of a slightly inflated central body, subcircular in outline, and five rigid arms which are not a part of the body cavity. The arms are in a single plane, about twice as long as the diameter of the central body, and about one-half as wide as same; longitudinally the arm margins are parallel except distally where the arms taper and are terminally rounded. The dorsal side of the arms is angularly convex in cross-section; ventrally the arm proper is deeply concave, but fitted with a covering of plates, two rows that interfinger and alternate in position. The plates bear prominent subconical protuberances along the outer margins, one to each plate, or a total of about eight in each row. A subcircular centrodorsal plate is considerably elevated

above the body cavity; the plate bears a small circular central perforation.

Dimensions: Diameter of body cavity, 0.6 mm; length of arms, 0.9 mm; width, 0.36 mm.

Holotype, no. 46031.

Remarks.—This species is based on an individual that is markedly different from described forms. The symmetry is strongly suggestive of the stelleroid groups, and if the specimen belongs to one of these, the perforated dorsal plate should represent a madreporic or an anal plate, and the ventral arm tubercles might possibly be homologues of ampullae. If, on the other hand, the form belongs to the pelmatozoans, the dorsal plate should represent a facet that formerly marked the connection of a columnal. It is also possible that this is a rare type of bryozoan, similar to those of the genus *Evactinopora*.

Phylum BRYOZOA

Family CERAMOPORIDAE

Genus CERAMOPOPRELLA Ulrich, 1882

CERAMOPORELLA RACINENSIS Grubbs,
n. sp.

Plate 61, figure 37

Zoarium encrusting, consisting of thin-walled, close-spaced, alternating and imbricating zoecia radiating more or less uniformly from a common noncelluliferous mid-area. Zoecia tubular, oblique, the greater part covered by subangular hoods, extensions of the lunaria, which commonly show a slight ridge at the apex. Apertures subangular, obliquely directed; maculae and diaphragms lacking. Mesopores large, occupying most of the interzoecial space, a single row separating adjacent zoecia, two or three pores to a distance equalling the length of a zoecial hood.

Dimensions of holotype (no. 46032): diameter, 5.0 mm; diameter of zoecia 0.35 mm. three zoecia to a longitudinal distance of 2 mm.

Remarks.—This species resembles *C. interporosa* Ulrich, from the Ordovician. It differs in that the zoecia are more regularly disposed and the hoods are stronger, more angular, and have an apical ridge. It differs from the Silurian forms *C. orbiculata* (Ringenberg) and *C. irregularis* Bassler in that maculae have not been observed, but all

growth is a radiation from a central area. Rare in the samples.

Genus *PHOLIDOPORA* Grubbs, n. gen.

Zoarium thin, encrusting in the early stages, at maturity developing a concentrically wrinkled epithecal membrane over the lower surface and retaining a sub-central cicatrix of attachment. Zoecia tubular, oblique, irregularly alternating and imbricating, radiating from a central area; lunaria extended into strong hoods; zoecial chambers with a few partial diaphragms or hemiphragms, noncommunicating. Maculae and mesopores lacking.

Genotype, *Pholidopora concentrica* Grubbs, n. sp.

Remarks.—This genus has several distinctive features which separate it from other genera of the encrusting cyclostomous bryozoans. The epithecal membrane seems to be distinctive in this genus, and the lack of mesopores separates it from several genera. The zoecia are separated by rather thick intervening spaces. A feature of the zoecial chambers is the development of partial diaphragms, so-called hemiphragms, which extend partially across the chambers but do not divide them into compartments.

PHOLIDOPORA CONCENTRICA Grubbs, n. sp.
Plate 61, figures 39, 40, 47

Zoarium thin, encrusting in the early stages and at maturity developing a convex concentrically wrinkled and striated epithecal membrane over the lower surface. The membrane retains a central cicatrix of attachment. Zoecia short, tubular, radiating irregularly in an alternating and imbricating manner, separated by wide intervening spaces, obliquely directed, more so toward the periphery than near the mid-area; lunaria projecting into the zoecia posteriorly, extended anteriorly into highly arched hoods, subangular in section, the hood apex acutely rounded, hoods curving slightly near the point of origin then straightening toward the aperture. Zoecial chambers with one or two partial diaphragms or hemiphragms originating from the side of the walls and reaching nearly to the midline, terminating with a straight margin, which is perpendicular to the axis of growth of the individuals. In some cases two hemi-

phragms oppose one another but more commonly their position is alternate. The straight margins produce the appearance of an open rectangular notch in anterior view. Inter-zoecial areas without mesopores; surface without maculae; apertures elliptical.

Dimensions of holotype: maximum diameter of zoarium, 6.8 mm; diameter of zoecia, 0.25 mm; zoecia spaced 5 to 3 mm longitudinally.

Holotype, no. 46033; paratypes, no. 46034.

Remarks.—The distinctive characteristics of this species have been listed under the generic discussion. The broad inter-zoecial spaces, the lack of mesopores, the hemiphragms, and the concentric lower membrane distinguish this species from other ceramopoids.

Family BATOSTOMELLIDAE

Genus *LIOCLEMELLA* Foerste, 1895

LIOCLEMELLA CLAVA Grubbs, n. sp.

Plate 61, figures 41–43

Zoaria consisting of tapering, clublike stems, occasionally branching, the proximal end pointed for articulation. Zoaria subcircular in cross-section, the greatest diameter near the rounded distal extremity; centers of the individual zoaria hollow, commonly assuming a spiral character. Zoecia subcircular, more or less regularly spaced, six in a distance of 4 mm, oblique at first, then directed toward the surface. In most individuals a few large pores or holes occur at or near the distal end, probably irregularities of preservation or replacement.

Dimensions of holotype: length of zoarium, 20.0 mm; greatest diameter, 4.0 mm.

Holotype, no. 46035; paratypes, no. 46036.

Remarks.—These forms have been replaced by silica in such a manner that the detailed structure of the zoecia and walls has been obliterated, hence the species is erected principally on the basis of shape. It differs from *L. maccombi* Bassler in that the greatest diameter is near the distal end, and also the forms occasionally branch. It differs from *L. ohioensis* (Foerste) in that it is circular rather than elliptical in section, and the diameter is greatest near the distal end. Abundant.

Family PHYLLOPORINIDAE

Genus PSEUDOHORNERA Roemer, 1876

PSEUDOHORNERA? VARIPORA Grubbs, n. sp.

Plate 61, figures 44-46

Zoarium a frond, branching irregularly in one plane, growing from an expanded base; branches subcircular to elliptical in cross-section. Zoëcia deep, tubular, nearly direct, irregularly disposed over the convex obverse face, crowded in some portions. The apertural openings are subcircular, with a sharp peripheral rim raised slightly above the surface of the branches. Reverse side of branches convex, noncelluliferous, marked with three or four granulose, longitudinal striae.

Dimensions of holotype: length of zoarium, 3.5 mm, diameter of average branch 0.3 mm; diameter of apertures, 0.24 mm.

Holotype, no. 46037; paratypes, no. 46038.

Remarks.—This species is referred to the genus with some question, for irregularly spaced zoëcia apparently have not been observed before in *Pseudohornera*. The forms correspond to the generic description in the frondescent character and in that only one side bears zoëcia, the other being marked with striae. The species differs from *P. niagarensis* (Hall) and *P. diffusa* (Hall) in that it branches more irregularly, does not have an angular obverse face, and in the character of the zoëcia mentioned above. Uncommon in the samples.

Family FENESTRELLINIDAE

Genus FENESTRELLINA d'Orbigny, 1849

FENESTRELLINA PERCARINATA

Grubbs, n. sp.

Plate 62, figures 1, 2

Branches essentially straight, depth more than twice as great as width due to a strong obverse keel; fenestrules rectangular or elongate-ovate as the result of the distal expansions of the dissepiments, length of fenestrules about twice the width. The dissepiments are rounded, considerably expanded at the junctions with the branches, width about one-half that of the branches. Obverse side of branches with a strong, sharp keel which accounts for more than one-half the depth of the branches. The

zoëcia are arranged in two alternating rows, a row on each side of the keel; apertures subcircular, three or four to a fenestrule, spaced about two-thirds the width of an aperture apart. Apertures situated on an oblique face produced by the keel at its junction with the branch proper, the apertural plane forming an angle of about 15° with the vertical. Reverse side of branches angularly convex, with the suggestion of a slight keel, or in some cases more nearly rounded. Both faces of branches, keel included, ornamented with minute tubercles, arranged in several rows, producing the appearance of striae on casual observation.

Dimensions of holotype: width of branch, 0.37 mm; depth including keel, 1.5 mm; length of fenestrule, 0.93 mm; width, 0.44 mm; diameter of aperture, 0.12 mm; apertures spaced 10 to 2.5 mm.

Holotype, no. 46039; paratypes, no. 46040.

Remarks.—Fragments of this species are common in the nodules, but zoaria of considerable size are lacking. The forms resemble the many described species of this genus; they are characterized by the extremely high keel, the oblique apertural plane, and the minutely spinose surfaces. In rare cases minute spines arise outside of the apertures and a short distance above are joined to form a ring, with about six short spines, which project inward from the inner margin of the ring.

Family ARTHROSTYLIDAE

Genus ARTHROSTYLUS Ulrich, 1888

ARTHROSTYLUS PENTAGONUS Grubbs, n. sp.

Plate 62, figure 4

Zoaria slender, straight, subpentagonal in cross-section; zoëcial openings in a single row on each of four sides, the fifth side narrower and without zoëcia, and marked with four longitudinal striae. Zoëcial apertures large, elongate-ovate, nearly direct, commonly with a peristomal ridge. An angular ridge marks the intersection of the faces bearing the zoëcia.

Dimensions of holotype: length of zoarium, 5.1 mm, diameter, 0.5 mm; zoëcia, 0.5 mm in length, spaced 9 to 5 mm.

Holotype, no. 46041; paratypes, no. 46042.

Remarks.—This species differs from *A.*

conjunctus Ulrich in that it has four rows of apertures rather than three, and the apertures are more elongate. It differs from *A. obliquus* Ulrich in its four zoöcial rows and in that the apertures are more direct with respect to the surface.

Family RHINIDICTYONIDAE

Genus RHINIDICTYA Ulrich, 1882

RHINIDICTYA AEQUIELLIPTICA Grubbs, n. sp.
Plate 62, figures 5-7

Zoarium bifoliate, attached by an expanded base, subcylindrical in the lower portion then expanding into paddle-like, elliptical bodies, in some cases tortuous, bifurcating at irregular intervals. The individual branches are acutely elliptical in cross-section, width commonly as much as five times the depth, sides subparallel, sharp, with a very narrow noncelluliferous margin; terminally the branches are convex in outline. Zoöcia irregularly arranged around the basal portion, filled with sclerenchyma; above the base the zoöcia are regularly disposed on both faces of the elliptical portions of the branches, in from three to six, most commonly five alternating rows; apertures of the marginal rows somewhat larger than those of the inner rows, directed slightly obliquely outward. Zoöcia directed slightly toward the anterior, separated by moderately thick walls, apertures elongate, regularly elliptical, length about twice the width. The upper edges of the walls separating the zoöcia are marked with rows of minute spines, with the appearance of striae, especially prominent on the lower portion of the zoarium. From one to three faint outwardly divergent striae commonly are visible in the bottom of the zoöcia; commonly they are better shown near the margins.

Dimensions of holotype: width of branch 1.9 mm; depth 0.9 mm; length of average aperture, 0.5 mm; width, 0.25 mm; zoöcia spaced longitudinally eight to a distance of 5 mm.

Holotype, no. 46043; paratypes, no. 46044.

Remarks.—This species is abundantly represented in the material. Its mode of development and elliptical character of the branches resemble very closely *R. exigua* Ulrich from the Ordovician, but it differs

in that the apertures are more uniformly elliptical, the zoöcia are directed toward the distal extremities, and the bottoms of the zoöcia are marked with striae.

Phylum BRACHIOPODA

Order NEOTREMATA

Family CRANIIDAE

Genus PHOLIDOPS Hall, 1859

PHOLIDOPS PARVUS Grubbs, n. sp.
Plate 62, figure 3

Shell small, oblong-ovate in outline, bi-convex, greatest width near the midline. Ventral valve eccentrically convex with a flattened indistinct beak situated in the posterior half of the valve; slope from beak to the posterior steeper than slope to the anterior. Dorsal valve less convex than the ventral. Surface commonly marked with five or six imbricating growth lines. The interior of the ventral valve shows a subcircular thickening with a bilobate aspect, suggestive of two sets of adductor muscles. Dorsal interior with an indistinct complement.

Dimensions of holotype: length, 2.5 mm; width, 2.2 mm.

Holotype, no. 46045; paratypes, no. 46046.

Remarks.—This rather common form is similar in general shape and aspect to several species of the genus. It differs from the Silurian *P. ovalis* Hall in that it is more elongate and shows fewer growth lines. It also shows fewer growth lines than Devonian species and usually its ventral valve is not as deep and its beak not as prominent as in other species.

Order PROTREMATA

Family SPHENORTHIDAE Grubbs, n. fam.

Primitive compressed-elongate Orthacea with short, curved hinge lines; deltidia, chilidia, cardinal processes, and spondylia wanting.

Genus SPHENORTHIS Grubbs, n. gen.

Small, compressed, elongate-triangular shells, laterally concavoconvex; hinge line short and strongly curved; delthyrium large, open. Surface multicostate. Ventral hinge simple, short teeth bounding the delthyrium; dorsal cardinalia consisting of brachioophores without supporting plates.

Spondylia, septa, and cardinal processes lacking.

Genotype, *Sphenorthis niagarensis* Grubbs, n. sp.

Remarks.—This genus has several features characteristic of primitive Orthacea, notably the absence of a cardinal process and the lack of dental plates and lamellae. The wide, open delthyrium, the character of the brachiophores, and the position of the ventral teeth are attributes of the group. A new genus and a new family are necessary since the singular form of the species, the curved hinge line, and the internal features do not permit placing it in any established category.

SPHENORTHIS NIAGARENSIS Grubbs, n. sp.
Plate 62, figures 9–11

Shell small, transverse-spatulate, compressed, elongate-triangular in outline, length about twice as great as width, greatest width at or near the anterior extremity. The lateral margins are blunt, nearly straight, and converge toward the posterior; shell in the posterolateral region deep, producing the appearance of a broadly curved, false interarea that is wide at the posterior and diminishes around the lateral margins toward the anterior. The shell is concavoconvex in lateral section; ventral valve broadly arched laterally, nearly flat transversely, with a prominent flattened beak extending for a considerable distance past the posterior margin of the dorsal valve, beak not incurved; ventral interarea apsacline, short, triangular, high, occupied almost entirely by a large open delthyrium. Dorsal interarea extremely low, almost imperceptible, with a slight median notch; beak represented by a slight boss. Surface of both valves with about 11 strong, non-bifurcating transverse ribs radiating from the apex; ribs crossed by numerous slightly flared concentric lirations.

The interior of the ventral valve is fitted with a pair of small teeth, one at each side of the delthyrium; dorsal interior with a pair of subparallel, moderately long, anteriorly pointed brachiophores, which are not supported by plates and unite with the shell at the posterior extreme. Spondylium, septa, and cardinal process lacking.

Dimensions of holotype (no. 46047):

length, 4.3 mm; width, 2.5 mm; thickness, 1.2 mm.

Remarks.—This species is based on a single individual, but its extraordinary shape and perfect state of preservation warrant its introduction to the literature. In order to keep the specimen intact only those internal features were described which could be observed through the large open delthyrium. Apparently the form belongs to the superfamily Orthacea.

Family ANOMALORTHIDAE
Genus ANOMALORTHIS Ulrich and
Cooper, 1936
ANOMALORTHIS CHICAGOENSIS
Grubbs, n. sp.
Plate 62, figures 8, 13

Shell small, resembling *Cyrtina*, hemipyramidal, subquadrate in outline, width somewhat greater than length. The hinge line is straight, slightly shorter than the greatest width of the shell. Ventral valve convex-hemipyramidal, interarea triangular, high, slightly concave, with a large open, triangular delthyrium; in young forms a convex deltidium covers the apex of the delthyrium; beak prominent, slightly incurved. The dorsal valve is gently convex, with a slight notch at the posterior margin opposing the ventral delthyrium; beak small. Surface of ventral valve ornamented with commonly 13 rounded plications, the median one slightly larger than the others and forming a small fold at the anterior margin; dorsal exterior with corresponding plications and a slight anterior sulcus. Both valves marked with three or four concentric growth lines.

Ventral interior with a prominent, thickened, sessile spondylium; hinge teeth small, at lateral margins of the delthyrium; dental plates directed ventrally to coalesce with the lateral margins of the spondylium. Dorsal cardinalia orthid in character; brachiophores strong, bounding a small, shallow notothyrial cavity, directed anterolaterally; cardinal process a rather strong rounded median ridge, myophore roughened.

Dimensions of holotype: length, 1.0 mm; width, 1.4 mm; thickness, 0.6 mm; figured ventral valve: length, 2.1 mm; width, 2.5 mm.

Holotype, no. 46048; paratypes, no. 46049.

Remarks.—Individuals of this species are uncommon in the material. They resemble in many respects species described by Ulrich and Cooper, but differ in that the surface ornamentation is in the form of undulant plications rather than multicostellate. The general outline and convexity of the valves also differ from other species.

Family STROPHOMENIDAE

Genus PLECTAMBONITES Pander, 1830

PLECTAMBONITES CONCENTRILIRATUS

Grubbs, n. sp.

Plate 62, figures 12, 15–17

Shell small, semicircular in outline, concavo-convex, width greater than length. The hinge line is straight and is the greatest width of the shell; cardinal extremities extended into wings or acuminate points. Ventral valve more or less evenly convex transversely, concave laterally from the umbo toward the extremities; anterior margin evenly convex. The beak is small, pointed, perforated by a small circular foramen, incurved over an extremely low triangular interarea, which extends the entire width of the shell and bears a small,

triangular delthyrium; delthyrium with an arcuate, convex deltidium at the apex. Dorsal valve concave, closely fit to ventral valve, with a minute beak and an interarea of smaller proportions than that of ventral valve. Shell surface smooth except for very fine concentric lirations.

Ventral hinge teeth small, at each side of the delthyrium. The dorsal valve bears short, rather strong, stumplike brachipophores closely spaced to confine pedicle passage, extending slightly posteroventrally and passing into a cardinal process, which occupies part of the delthyrium and is visible from the exterior; myophore roughened. Inner surface of both valves with numerous short, anteriorly directed spines, arranged more or less in alternating rows.

Dimensions: There is considerable range in the size of the individuals of this species. The holotype is 3.0 mm long and 6.0 mm wide. This is average for the group.

Holotype, no. 46050; paratypes, no. 46051.

Remarks.—This species differs from most of the members of the genus in that it is not longitudinally striate, but concentrically marked. The spinose character of the in-

EXPLANATION OF PLATE 62

- FIGS. 1, 2—*Fenestrellina percarinata* Grubbs, n. sp. 1, Obverse surface of paratype, $\times 3$; 2, reverse surface of holotype, $\times 4$. (p. 553)
 3—*Pholidops parvus* Grubbs, n. sp., $\times 6$. Ventral view of paratype. (p. 554)
 4—*Arthrostylus pentagonus* Grubbs, n. sp., $\times 9$. Lateral view of holotype. (p. 553)
 5–7—*Rhynidietya aequielliptica* Grubbs, n. sp. 5, Holotype, $\times 4$; 6, paratype, $\times 2$; 7, paratype, $\times 3$. (p. 554)
 9–11—*Sphenorthis niagarensis* Grubbs, n. gen. and sp. 9, Ventral view of holotype $\times 5$; 10, dorsal view of holotype, $\times 5$; 11, lateral view of holotype, $\times 3$. (p. 555)
 8, 13—*Anomalorthis chicagoensis* Grubbs, n. sp., $\times 8$. 8, Interior of ventral valve of paratype; 13, ventral view of paratype. (p. 555)
 12, 15–17—*Plectambonites concentriliratus* Grubbs, n. sp. 12, Posterior view of holotype, $\times 3$; 15, ventral view of holotype, $\times 5$; 16, dorsal view of holotype, $\times 4$; 17, ventral view of paratype, $\times 4$. (p. 556)
 14, 18–20—*Schuchertella perconcinna* Grubbs, n. sp. 14, Dorsal view of holotype $\times 4$; 18, ventral view of paratype, $\times 4$; 19, posterior view of holotype, $\times 3$; 20, dorsal view of paratype, $\times 6$. (p. 557)
 21–25—*Atrypina magnaventra* Grubbs, n. sp. 21, Dorsal view of holotype, $\times 5$; 22–24, dorsal, ventral and lateral views of paratype, $\times 3$; 25, dorsal view of paratype, $\times 3$. (p. 557)
 26–28—*Homoeospira cyclothyra* Grubbs, n. sp., $\times 4\frac{1}{2}$. Ventral, dorsal, and lateral views of holotype. (p. 558)
 29, 30, 32—*Propatella magnacostata* Grubbs, n. gen. and sp. 29, Upper surface of paratype, $\times 8$; 30, upper surface of holotype, $\times 6$; 32, lateral view of holotype, $\times 6$. (p. 558)
 31, 33, 34—*Punctopatella corallifera* Grubbs, n. gen. and sp. 31, Lateral view of holotype, $\times 6$; 33, upper surface of holotype, $\times 7$; 34, upper surface of paratype, $\times 7$. (p. 559)
 35–39—*Beyrichia gregaria* Grubbs, n. sp. 35, Left valve of holotype, $\times 7$; 36, ventral view of holotype, $\times 7$; 37, dorsal view of paratype, $\times 5$; 38, right valve of paratype, $\times 7$; 39, left valve of paratype, $\times 7$. (p. 559)



Grubbs, Niagaran fauna

terior is distinctive, and the species may therefore belong to a new genus.

Genus SCHUCHERTELLA Girty, 1904

SCHUCHERTELLA PERCONCINNA

Grubbs, n. sp.

Plate 62, figures 14, 18-20

Shell small, unequally biconvex to subplanoconvex, semicircular in outline. Shell slightly wider than long, greatest width at or near the straight hinge line; anterior margin rounded. Valves subequal; ventral valve more convex than dorsal and bears a slightly elevated umbo and a rather small incurved beak; apex of beak perforated by a minute circular foramen. Valve surface, from the umbo laterally to the cardinal extremities, flattened or in some individuals slightly concave. Ventral interarea low, slightly concave, triangular, and does not reach the cardinal extremities; delthyrium triangular, slightly broader than high, with an arcuate, convex deltidium covering the apical portion. The dorsal valve is gently convex, approaching flatness in some individuals; beak small, incurved. Surface of both valves with strong, rounded costae, radiating from the umbones. There are commonly 11 primary costae on the dorsal valve and 12 on the ventral valve, intercalated with a variable number of shorter secondary costae. Numerous indistinct, concentric growth lines present a fluted appearance where they cross the costae.

Ventral valve fitted with rather strong teeth at lateral margins of the delthyrium and dental plates which extend toward and finally coalesce with the shell to form curved septa, convex toward the midline. The dorsal valve bears strong anteriorly pointed brachiophores arranged in a broad V, the apex extending past the posterior margin to produce a short cardinal process. Myophore roughened by small tubercles and extending posteriorly slightly past the interarea, so that it is visible on the exterior of the shell. There is an interior reflection of the outer surface markings.

Dimensions: The individuals range in width from 1.0 mm to 7.0 mm. Holotype: length, 3.3 mm; width, 5.5 mm; thickness, 1.2 mm.

Holotype, no. 46052; paratypes, no. 46053.

Remarks.—This species has several features in common with related forms: It differs from *S. subplana* (Conrad) and *S. interstriata* (Hall) in that the hinge line is the greatest width of the shell and the costae are coarser. The costae, although not as numerous, have the appearance of *S. pecten* (Roemer) from Tennessee. The hinge features and cardinalia are similar to *S. subplana* (Conrad).

Order TELOTREMATA

Family ATRYPIDAE

Genus ATRYPINA Hall and

Clarke, 1893

ATRYPINA MAGNAVENTRA Grubbs, n. sp.

Plate 62, figures 21-25

Shell small, roughly elongate-pentagonal, length greater than width, greatest width near the median part of shell. The margin is bluntly rounded anteriorly, diverges to the greatest width of the shell, then converges more acutely to the posterior. Hinge line short, strongly curved. Ventral valve deeply convex, with a large, rounded, greatly incurved beak, which extends well past the posterior margin of the dorsal valve and is truncated by a large circular foramen. Delthyrium covered in young individuals with deltidial plates, obscured in mature forms by the incurved beak of ventral valve. Dorsal valve gently convex or nearly flat; beak small, obscured by ventral beak. Surface of the ventral valve with six broadly rounded plications, the two median ones elevated in the form of a shallow fold, which dies out at the umbo; dorsal valve with five plications, the median one in a shallow sulcus, which dies out near the center of the valve; plications non-bifurcating. Usually two or three imbricating growth lines are present; shell rather thick.

The interior of the ventral valve has small laterally striated dental plates, which pass into strong, rounded teeth, recurved toward the posterior. The teeth articulate in sockets of the dorsal valve at the sides of small plates, which are in a subparallel position with respect to the horizontal; the plates approach the mid-line but are separated by a rectangular notch.

Dimensions of holotype: length, 4.7 mm; width, 3.5 mm; thickness, 2.3 mm.

Holotype, no. 46054; paratypes, no. 46055.

Remarks.—This species is similar in many respects to *A. disparilis* (Hall) and *A. intermedia* (Hall), but differs in that it is more elongate, more ventricose, has a more strongly developed ventral beak, and the plications do not bifurcate. Common in the samples.

Family RHYNCHOSPIRINIDAE
Genus HOMOEOSPIRA Hall and
Clarke, 1893

HOMOEOSPIRA CYCLOTHYRA Grubbs, n. sp.
Plate 62, figures 26–28

Shell small, oblong-subovate in outline, biconvex, nearly twice as long as wide, the greatest width just anterior to the midpoint of the ventral valve; anterior margin bluntly rounded and slightly indented at the midline. Valves subequally convex; hinge line short and strongly curved. The ventral valve is slightly the more convex and bears a pointed incurved beak, which extends for some distance past the dorsal posterior; delthyrium covered by moderately large, flat or slightly convex deltidial plates, which coalesce and produce a slight median ridge at their junction. A circular foramen is situated at the apex of the plates, under and bounded by but not transgressing, the extreme apex of the beak. Dorsal valve subovate in outline, its beak incurved, obscured by that of ventral valve. Ventral surface commonly with 11 rounded, nonbifurcating costae, radiating from the umbo, two costae slightly elevated in the form of a broad fold, separated by a wide intervening space in the form of a shallow sulcus bearing a very small rib. The dorsal valve has a corresponding number of costae, the two median ones about half as strong as the others and occupying a shallow sulcus, which diverges from the umbo with a slight outward curve; both valves with fine concentric lirations and stronger growth lines.

Ventral interior with short, strong teeth, originating from the lateral margins, curved toward the posterior; articulating outside of the dorsal brachioophores; dorsal valve with subparallel brachioophores extending into the ventral umbonal cavity, supported by plates which are directed laterally and coalesce with the shell; brachioophores sepa-

rated by a wide, angular notch; median septum rudimentary. Spiralia spinose, consisting of three or four volutions; jugum complete.

Dimensions of holotype: length, 4.0 mm; width, 2.5 mm; thickness, 1.8 mm.

Holotype, no. 46056; paratypes, no. 46057.

Remarks.—This species differs from *H. evax* (Hall) and most other species of the genus in that the foramen is confined to the apex of the deltidial plates. It is also more elongated and its surface markings are distinctive.

Phylum MOLLUSCA
Class GASTROPODA
Family ACMEIDAE

Genus PROPATELLA Grubbs, n. gen.

Moderately low, nonspiraed, cone-shaped patellids with a subcentral apex; surface with strong radiating ribs, elevated above the shell surface and not reflected on the interior; inner surface finely punctate; muscle scars represented by a slight impression on each side of the apex.

Genotype, *Propatella magnacostata* Grubbs, n. sp.

Remarks.—This genus differs from forms generally assigned to *Palaeacmaea* Hall in the punctate inner surface and in that the strong radial ribs are not reflected on the interior of the shell.

PROPATELLA MAGNACOSTATA
Grubbs, n. sp.

Plate 62, figures 29, 30, 32

Shell a small, ribbed cone, subcircular or slightly ovoid in outline. A high, rather prominent, nonspiraed apex is eccentrically located nearer to and incurved toward the posterior, producing a slight posterior concavity in lateral aspect; slope anterior from the apex slightly convex. Surface ornamented with a variable number (commonly 10 or 12) primary, strong, elevated, rounded ribs, intercalated with numerous secondary ribs, the total in some specimens reaching 40. In section the ribs are horseshoe-shaped, hollow; they radiate from a point a little below the apex, increase in size toward the periphery, and extend for as much as one-fourth their length past the edge of the shell proper. On larger forms the ribs are ragged

and broken by growth lines. The inner surface of the shell is minutely punctate; there is no interior reflection of the ribs. A faint impression in the shell interior on each side of the apex suggests muscle scars.

Dimensions of holotype: greatest diameter, 3.2 mm; height at the apex, 1.3 mm.

Holotype, no. 46058; paratypes, no. 46059.

Remarks.—This distinctive shell is placed in a new genus based principally on the ornamentation, with the strong radial ribs as the outstanding feature. Common in the material.

Genus PUNCTOPATELLA Grubbs, n. gen.

Moderately low, nonspiraled, cone-shaped patellids commonly with a subcentral apex; shell substance with the appearance of several imbricating layers, each layer reticulated by regularly arranged circular punctae; muscle impressions on each side of the apex.

Genotype, *Punctopatella corallifera* Grubbs, n. sp.

Remarks.—The shape of the shell in this genus resembles *Propatella* Grubbs and several species of *Palaeacmaea* Hall. The punctate nature of the shell is the distinguishing characteristic.

PUNCTOPATELLA CORALLIFERA Grubbs,
n. sp.

Plate 62, figures 31, 33, 34

Shell a small cone, subcircular or slightly ovoid in outline, margin in some cases irregular or roughly lobed. Apex high, nonspiraled, eccentric, nearer to and slightly incurved toward the posterior. Shell wall with the appearance of multiple layers, each layer reticulated by numerous circular punctae; outer surface bears occasional imbricating concentric growth lines, which tend to curl slightly. The shell is somewhat thickened on the inner edge of the periphery to form an inner ring or lip. Shell interior minutely punctate, with faint muscle impressions on each side of the apex.

Dimensions of holotype: greatest diameter, 2.2 mm; height at apex, 1.3 mm.

Holotype, no. 46060; paratypes, no. 46061.

Remarks.—This shell resembles closely

Propatella magnacostata Grubbs in outline and features of shape; the interior features are also similar. The external surface of this species roughly resembles a colonial coral because of the regular spacing of the circular punctae.

Phylum ARTHROPODA

Class OSTRACODA

Genus BEYRICHIA McCoy, 1846

BEYRICHIA GREGARIA Grubbs, n. sp.

Plate 62, figures 35–39

Carapace large, oblong-subquadrate in outline, obese, cardinal extremities well defined. Hinge line straight, dorsal margin straight except where modified by anterior and posterior lobes; ventral margin gently convex, its greatest convexity in the posterior quarter. Anterior outline broadly curved toward venter, slightly flattened toward dorsum, joins the hinge line at an angle of a little more than 90°; posterior outline more obliquely curved toward the venter, flattening toward the dorsum, with a slight concavity below the cardinal angle; posterior cardinal angle somewhat greater than the anterior. Carapace highest somewhat behind the midline, its greatest thickness below and anterior to midpoint. Valves subequal, both valves marked with strong, sharp, false keels, which parallel the venter, are reduced toward and die out near the hinge line. Hinge simple.

Valves with a roughly bilobate aspect, but the posterior lobe is modified by the development of a smaller third lobe, which occupies the median position on the carapace. The anterior lobe is the larger, occupying most of the anterior half of the carapace and protruding as a curved ridge slightly above the dorsal margin. Median lobe a slightly bulbous protuberance located above and behind the midarea of the shell, somewhat diagonally elongated in a posterodorsal-anteroventral direction, and connected to the anterior lobe by a slightly expanded extension, which passes underneath a median sulcus. Median lobe separated laterally from the anterior lobe by the median sulcus, which extends a short distance into the ventral half of the carapace and dies out into the dorsal margin. Sulcus deeply incised below, shallow above, flared at the dorsal margin. The median lobe is

separated from the posterior lobe by a shallow, poorly defined sulcus. Posterior lobe less inflated than the anterior, protrudes above the hinge line as a bluntly angular projection subequal in height to dorsal extension of anterior lobe.

Females of this species show, along the posteroventral margin, a large, bulbous, somewhat elongate brood pouch, which extends anteriorly a short distance beyond midcarapace.

The surface is smooth except for shallow pits, which apparently are the result of irregular replacement of the original shell material by silica.

Dimensions of holotype: length, 2.8 mm;

height, 1.6 mm; thickness, 1.8 mm. Average length of female brood pouch, 1.0 mm.

Holotype, no. 46062; paratypes, no. 46063.

Remarks.—This species resembles *B. kloedeni* McCoy in the development of the brood pouch. In general shape and appearance it is similar to *B. moodeyi* Ulrich and Bassler and *B. veronica* Ulrich and Bassler but lacks the marginal fringe developed by these species, and the brood pouch is not as large and is restricted more to the posterior. *B. gregaria* differs from these and other described species in the presence of the dorsal projections of the anterior and posterior lobes.

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